Evaluation of Juvenile Chinook Salmon Salvage Efficiency at the Tracy Fish Collection Facility

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Summary

The Tracy Fish Collection Facility (TFCF) was designed to divert juvenile Chinook salmon (*Oncorhynchus tshawytscha*) and striped bass (*Morone saxatilis*) from south Sacramento-San Joaquin River Delta (Bates *et al*. 1960). The TFCF uses a louver-bypass system to divert and guide fish into collection tanks, where they are held until they are transported back to the Delta, away from the facility. Fish and exported flows enter the facility through a trashrack with 5.1-cm-wide (2.0-in) bar spacing and travel through the 25.6-m-wide (84-ft) primary channel to one of four bypass entrances along the louver wall. Once inside the bypass entrance, fish travel downward into underground bypass tubes to the secondary channel where they encounter a double louver wall. Fish that are guided successfully by these louvers are diverted to one of four holding tanks. One to three times daily, fish are removed from each holding tank and returned to the Sacramento-San Joaquin Delta.

The efficiency of louvering systems to properly guide Chinook salmon is dependent on the water velocity in the facility's primary and secondary channels and the bypass ratio (BR), defined as the ratio of the water velocity entering the bypass openings to the average channel velocity upstream of the louvers (Bates *et a*l. 1960, DWR 1967a, 1967b, Bowen *et al*. 2004). Bypass ratios above 1.0 provide a "capture velocity" when fish near the bypass entrance.

Water velocity and BR are such critical components guiding the efficiency of the TFCF that special operating guidelines have been specified in multiple regulatory documents (SWRCB Decision-1485, NMFS 2004, USFWS 2004). Primary channel

velocity is controlled by the number of pumps operating at the Jones Pumping Plant (JPP) and the tidal stage, and there are no legal requirements for maintaining a certain velocity. The minimal current facility criteria are as follows:

- Primary BR >1.0 (average primary bypass entrance velocity/average primary channel velocity)
- Secondary BR >1.0 (average secondary bypass entrance velocity/ average secondary channel velocity)
- Secondary channel velocity approximately 0.3–0.45 m/s (1.0–1.5 ft/s) May 15–October 31
- Secondary channel velocity approximately 0.9 m/s (3.0 ft/s) November 1–May 14

In FY 2009, we completed 26 release-recovery efficiency experiments (day, night, crepuscular) at low primary channel velocities (<0.5 m/s, 1.7 ft/sec; 2–3 JPP pumps in operation). Preliminary analyses suggest facility efficiencies were much higher at night than day or crepuscular periods. This information will help refine our understanding of facility efficiencies for juvenile Chinook salmon under all operating scenarios which may affect facility operations.

Problem Statement

Chinook salmon are declining in the Central Valley of California and three races are protected by the National Marine Fisheries Service (winter and spring runs-Federal Register 70(123):37160-37204, June 28 2005; fall run- Federal Register 69(73):19975-19979, April 15, 2004). Chinook salmon may be entrained at the TFCF from late fall through late spring. Our study will determine whole facility efficiency for juvenile Chinook salmon under "salmon operating criteria" (see above). In FY 2011, we will determine Whole Facility Efficiency (WFE), Primary Louver Efficiency (PLE), and Secondary Louver Efficiency (SLE) of juvenile Chinook salmon when two to five pumping units are in operation at the JPP.

Goals and Hypotheses

Goal:

1. Determine WFE, PLE, and SLE for a range of JPP conditions at the TFCF: one to five JPP pumps in operation: determine facility efficiencies when secondary channel velocity is constant (>0.9 m/s, 3 ft/s) and primary BR varies (but always >1).

Hypothesis:

1. There is no difference in Chinook salmon WFE or PLE at different primary channel bypass ratios.

Materials and Methods

We will use release recapture experiments to measure facility efficiencies. We will determine which type of test will be performed depending on the number of pumps in operation at the JPP in March/April 2011.

Juvenile Chinook salmon (4,300) will be obtained from either Mokelumne or Feather River Fish Hatcheries (California Department of Fish and Game) in late February

2011. Fish will be held in flow-through 750-L (198-gal) tanks in well water (18°C) and fed Silver Cup salmon feed. Two weeks prior to testing, 4,200 fish will be fin tagged with fluorescent microbeads (New West Technology, Arcata, CA) into the following tag groups: Tags 1–6: 500 fish each (24 primary channel releases, 12 day/12 night), Tags 7–12: 180 fish each (24 secondary channel releases, 12 day/12 night). One hundred fish will be fin-clipped for holding tank control releases. These fish are released to test whether the lift bucket and screen are securely in place each experiment. Experimental fish will be acclimated to ambient Delta water conditions for 7 d prior to use.

For each experiment (3 replicates/24-h period), 100 fish will be released at five locations (20/location) just downstream of the trashrack, 40 fish released at the anterior end of the secondary channel, and 10 fish released into the holding tank. Each morning before the experiments begin, the trashrack and primary louver array will be cleaned. Then the secondary louver arrays will be cleaned and predators removed from the secondary channel. We will begin preparation for an experiment by counting test fish and placing them in 18.9-L (5-gal) buckets (20 fish/bucket). While counting takes place, the target secondary channel velocity is achieved by manipulation of the VC pumps. Once target hydraulics are established and stabilized, Replicate 1 for that 24-hr period will begin. This will be repeated 30 and 60 minutes (min) later for a total of three experimental releases per 24-h period. Holding tank and sieve net samples will be taken simultaneously every one-half hour for 2 hours. Recovered fish will be sorted by color code and measured.

Hydraulic measurements will be taken every 30 min throughout each experiment to ensure that average secondary channel velocity remains within the acceptable target condition range (±0.06 m/s). Hydraulic data includes channel velocities and depths in the primary and secondary channels, discharge in the secondary channel and holding tank, primary and secondary channel bypass ratios, and ambient light condition.

Data Analyses

WFE will be calculated using:

WFE= (# recovered in the holding tank/100) × Holding Tank Efficiency (HTE)

SLE will be calculated using:

SLE= (# recovered in the holding tank/# recovered in the holding tank+# recovered in the sieve net) × HTE, and

PLE will be estimated using:

PLE = (WFE/SLE) X HTE

Analysis of Variance or Kruskal-Wallis one-way analysis of variance by ranks will be used to compare efficiency estimates among facility conditions.

Coordination and Collaboration

These studies will be coordinated with the California Department of Fish and Game's Delta diversion facilities reporting program, and the Tracy Fish Collection Facility staff. All work will be reviewed by the Tracy Technical Advisory Team through progress updates on request and reviews of study plans and all reports.

Endangered Species Concerns

Incidental "take" of ESA listed salmon, steelhead, and delta smelt is possible and such fish will be returned to Delta waters as quickly as possible. The total number of each ESA species incidentally caught or collected during the experiment will be recorded and sent to the reporting agencies. The incidental take from this research is covered under the TFCF Section 10 permit.

Dissemination of Results (Deliverables and Outcomes)

We hope to collect all trials described above in 2011. If so, we will publish a summary draft report in 2011 (also including FY 2009 data) as a volume in the Tracy Technical Report Series.

Literature Cited

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